**REVISED DRAFT**

# SECTION I. INTRODUCTION

## PURPOSE OF THE DISCUSSION

One objective of the Monitoring Program (established for irrigated agriculture in 2003) is to evaluate the effects of irrigated agriculture on surface waters of the State in the Central Valley. The purpose of this discussion is to provide a review of the first three years of monitoring (May 2004 through October 2006) that was conducted for the Irrigated Lands Program to the Central Valley Water Board and to Irrigated Lands Stakeholders (2007 Review).

This 2007 Review does not consider issues of compliance in the evaluation of data collected for the Monitoring Program. The intent of is solely to summarize the monitoring information and provide baseline information regarding water quality conditions, identify findings that can be made, and consider areas where the collection of more water quality data would be effective at understanding baseline conditions and providing guidance for management practice implementation.

## STRUCTURE OF THE 2007 REVIEW

In order to facilitate the discussion of the monitoring data, the Central Valley Region has been conceptually divided into four 'Zones' for the purpose of this Review. These Zones are generally considered to be based on distinctions that are geographic and that result in variations in topography, hydrology, and crop type. Figure I identifies the location of these zones within the Central Valley, and they are further described as follows:

**Zone 1** is comprised of the Sacramento River watershed that drains the northern part of the Central Valley into the Sacramento River. There are currently three active Coalition groups within Zone 1, including the Sacramento Valley Water Quality Coalition, the California Rice Commission, and the Goose Lake Coalition.

Zone 1 drains over 27,000 square miles of land, roughly 17 percent of the land area of California. The Sacramento River itself, more than 400 miles long, stretches from snow-capped Mount Shasta through the fertile Sacramento Valley to the San Francisco Bay Estuary, and it's watershed covers all or parts of 22 counties.

There are thousands of smaller water bodies in Zone 1, some with seasonal flow, and may include creeks and agricultural dominated water bodies. The latter include modified natural waterways or constructed agricultural drains that are used to convey water from field to field during the irrigation season, or move excess water for flood control. On average, over 22 million acre-ft of water flow through the Sacramento River watershed each year, making it the largest river in California. This is approximately one-third of the total runoff in the State. The most intensive runoff occurs in the upper watershed of the Sacramento River above Lake Shasta and on the rivers originating on the west slope of the Sierra Nevada. These watersheds produce an annual average of 1000 to 2000 acre-feet of runoff per square mile. The Feather River, which includes the Yuba River

flows, and the American River are two major tributaries. The Feather River is considered to be a natural tributary to the Sacramento River. The Colusa Basin drain drains the west side of the Sacramento Valley from Willows south to Knights Landing.

**Zone 2** includes parts of San Joaquin, Contra Costa, Alameda and Calaveras counties and the Delta, covering approximately 998,340 acres with approximately 544,667 acres that are considered irrigated lands. Participants in the ILP within Zone 2 include the San Joaquin and Delta Water Quality Coalition, and two irrigation districts – a small portion of the Oakdale Irrigation District and the entire South San Joaquin Irrigation District.

The four major drainages in Zone 2 are the San Joaquin River, Stanislaus River, Calaveras River, and Mokelumne River. There are thousands of other smaller water bodies in Zone 2, of which some are ephemeral (seasonal). Some of these include small streams and agricultural dominated water bodies, such as constructed agricultural basins and drains designed to convey water from field to field during the irrigation season or move excess water for flood control.

**Zone 3** is essentially the San Joaquin River Drainage. It includes the irrigated lands within the geographic areas represented by the East San Joaquin Water Quality Coalition, the Westside San Joaquin River Watershed Coalition, and the San Luis Water District Watershed Coalition.

The Westside Coalition is comprised mostly of water districts (17 water agencies) that collectively formed a coalition along with several managed wetland areas (state and federal wildlife refuges or management areas), and some individual dischargers who are not water district members. The Westside Coalition geographic boundaries encompass about 450,000 acres of irrigated lands under the waiver, and also include an additional 97,000 acres that are covered under a waste discharge permit with the Regional Board (No. 5-01-234). The San Luis Water District borders the Westside Coalition area on the southwest, and filed with the ILP as a coalition on behalf of its members. The San Luis District boundaries encompass approximately 66,000 total acres, of which approximately 35,000 are irrigated for agricultural production. On the east side of the river, in Zone 3, the water districts chose not to represent their members to the ILP. Individual dischargers in Zone 3 on the east side of the river fall within the East San Joaquin Coalition boundaries, regardless of their water district affiliations.

The geographic boundaries of the East San Joaquin Coalition extend from approximately the Stanislaus River on the north to the east-west stretch of the San Joaquin River on the south. The coalition area extends to the Region 5 boundary on the east, but nearly all irrigated lands in the East Coalition lie in the western one-third of the area, primarily on the valley floor. The East San Joaquin Coalition boundaries contain approximately 1.2 million acres of irrigated lands.

The Zone 3 area also includes four of the five water districts on the east side of the San Joaquin River that filed with the ILP as individual dischargers under the

ILP waiver program. These include Modesto, Turlock, and Merced Irrigation Districts, as well as a majority of the Oakdale Irrigation District also lies within the Zone 3 boundaries.

**Zone 4** encompasses the entire Tulare Lake Basin including portions of Fresno, Kings, Tulare, and Kern Counties. The Coalition Groups that are active within Zone 4 include the Westlands Coalition, and the Southern San Joaquin Valley Water Quality Coalition. The Southern San Joaquin Valley Water Quality Coalition is comprised of four subwatersheds, each of which conducts their monitoring and reporting with a fairly independent approach.

This region receives the majority of its surface water runoff from the Kings, Kaweah, Tule, and Kern Rivers that flow out of the Sierra Nevada Mountains on the east side of the San Joaquin Valley. The development and use of water from these rivers has played a major role in the history and economic development of the region. Major statewide water projects in the Tulare Lake region include the State Water Project's California Aqueduct, which includes a State/federal joint use segment known as the San Luis Canal. The aqueduct is along the western side of the valley, and it also pumps water over the Tehachapi Mountains for use in Southern California.

Water from the Sacramento-San Joaquin Delta is imported into the region through the California Aqueduct for both agricultural and urban purposes. Federal Central Valley Project (CVP) water is also exported from the Delta through the San Luis Canal to agencies with federal water contracts on the west side of the valley, such as Westlands Water District. On the eastern side of the valley, the CVP's Friant-Kern Canal runs south along the foothills and transports San Joaquin River water to agencies along the valley's eastern side and extends into Kern County. In some instances, water can be returned to the San Joaquin River from Zone 4, through the various water transport systems, including the Fresno Slough.

Groundwater pumped from the Tulare Lake Basin's aquifers account for about 33 percent of the region's total annual water supply (DWR Bulletin 160-05). Most towns and cities along the east side of the valley, including Fresno, Visalia and Bakersfield, rely primarily on groundwater. On the valley's western side, smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San Luis Canal to meet municipal demands because salinity, sulfate, boron, chloride, and selenium limit the uses of groundwater. Where groundwater quality is marginal to unusable for agriculture, farmers use good quality surface water to irrigate crops or blend higher quality surface water with poor quality groundwater to create a larger supply.

## 2007 REVIEW CONSIDERATIONS

Each individual monitoring program, whether it be University of California studies, Coalition Group Monitoring or SWAMP, has its own set of program objectives under which it operates. As a result there were some differences in the types of data collected, the requirements under which the data were collected and

processed in the laboratory and compared to acceptance criteria. These differences are discussed throughout the Review, although the reader is advised to consider this when independent conclusions are being drawn from this report.

Some of the data provided were not utilized in this 2007 Review, due to questions regarding data quality, such as laboratory hold-time considerations, or the absence of laboratory quality control documentation. An assessment also requires an adequate quantity of good quality data. Some areas of the Central Valley have been monitored at a consistent frequency over the three-year period comprising six to eight sampling events per year. Other areas within the Central Valley have a much lower frequency of monitoring from which to infer findings from the water quality data. These data limitations need to be considered.

The results from the more frequently monitored areas that are summarized in this review are effective to provide baseline information regarding water quality, and monitoring sites from trend data can be developed over time. The areas for which less data is available can be considered in conjunction with other information, such as pesticide use data and field observations, there is a need for more thorough monitoring investigation.

Finally, it should be recognized that a thorough review of quality control for every monitoring event did not take place in all cases, in particular with respect to the more recently submitted Coalition monitoring data. Therefore the results described in this 2007 Review should be considered to be draft.

## DATA INCLUDED IN THIS EVALUATION

Monitoring was initiated for the Irrigated Lands Program (ILP) in 2003 through a Water Board contract with the University of California (UC) to conduct an "Investigation of Water Quality In Agricultural Drains in the California Central Valley." An additional contract was developed to continue the study through the UC John Muir Institute for the Environment and the State Department of Fish and Game.

Sample collection and analyses also began with the implementation of the Monitoring and Reporting Program Plans (MRP Plans) for Coalition Groups and five Irrigation Districts, most of which began in the summer of 2004. In some instances, supplemental information from the Water Board's Surface Water Ambient Monitoring Program (SWAMP) is included in areas where minimal ILP specific monitoring data is available. The monitoring information used in this report has been generated through these programs up through to the submittal of the December 2006 Coalition Group Semi-Annual Monitoring Report.

The data that was included in this evaluation is summarized in Table I-1, Monitoring Data Summary, and incorporates monitoring from the following programs:

1. Central Valley Water Board Monitoring through the University of California (UC) Phase I in March and September of 2003 (Investigation of Water

Quality in Agricultural Drains in the California Valley). This data includes primarily general water quality parameters, and two species of water column toxicity. (Supplemental Monitoring Sites)

2. Two years of monitoring (July 2004 through March 2006) from the Central Valley Water Board monitoring through the University of California John Muir Institute for the Environment, and State Department of Fish and Game. This data set includes general water quality parameters, three species water column tests (algae tests were added), sediment toxicity tests, as well as pesticides and metals. (Supplemental Monitoring Sites)

3. Two years of Monitoring from Individual Dischargers – monitoring conducted through the MRP Plans of these five Irrigation Districts have been monitoring exclusively for the pesticides that they apply on their properties adjacent to the canals. Their MRP Plans do not include toxicity monitoring, metals or nutrients, or any of the pesticides and other chemicals that may be entering their system prior to deliver to farmers, or that may be entering their system via agriculture drainages from adjacent farmlands. (referred to as MRP Plan or Coalition Monitoring Sites)

4. Approximately two years of Coalition Group monitoring which, based on the phased approach, included for most Coalitions the general water quality parameters, *E.-coli* as a pathogen indicator, three species of water column toxicity and sediment toxicity tests. These first two years of Coalition Group Monitoring generally did not include pesticides, metals or nutrients, although some Coalitions did monitor for some of these constituents during this time. Monitoring generally began during the irrigation season of 2004 and included storm season monitoring. (referred to as MRP Plan or Coalition Monitoring Sites)

5. One irrigation season of Coalition Group monitoring data that incorporated phase II of the Coalition MRP. For most coalitions, this monitoring included pesticides, metals, and nutrients in addition to the parameters listed in #4 above. (Referred to as MRP Plan or Coalition Monitoring Sites)

6. The data in this report also incorporates a small amount of supplementary monitoring collected by the CVRWQCB staff, either through the SWAMP program or by Irrigated Lands Program staff. The SWAMP monitoring data that was utilized in this Review consisted of water column toxicity monitoring and general field parameters, excluding nutrients. (Supplemental Monitoring Sites)

**Table I-1**
**Monitoring Data Summary**

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|
| **Number of Monitoring Sites** | | | | |
| Coalition Sites (MRP Plan Sites) | 43 | 29 | 46 | 30 |
| Supplemental Sites | 53 | 29 | 37 | 46 |
| **Total No. Sites** | **96** | **58** | **83** | **76** |
| **Number of Samples Collected*** | | | | |
| Coalition Sites (MRP Plan Sites) | 277 | 194 | 528 | 126 |
| Supplemental Samples | 218 | 130 | 69 | 128 |
| **Total No. Samples** | **495** | **324** | **597** | **254** |
| **Number of Tests Performed** | | | | |
| Water Column Toxicity Tests | 495 | 324 | 597 | 254 |
| Sediment Toxicity Tests | 92 | 73 | 162 | 71 |
| Pesticide Tests | 407 | 200 | 712 | 107 |
| Metal Tests | 341 | 141 | 182 | 87 |
| Pathogen Tests | 262 | 195 | 633 | 325 |
| Other Measurements | 754 | 463 | 1,145 | 820 |

* Based on number of water column toxicity tests

In general, the parameters or constituents that were monitored can be categorized as follows:

- Toxicity in sediment,
- Toxicity in water,
- Pesticides,
- Metals,
- Bacteriological analyses,
- Dissolved oxygen and pH,
- Salinity as measured by total dissolved solids and/or electrical conductivity, and
- Nutrients (phosphorus- and nitrogen-containing compounds including phosphate, nitrate, and ammonia).

The specific parameters, such as pesticides and metals, that were analyzed in individual samples, and the number of pesticides analyzed in each sample, were dependent upon the coalition or irrigation district specific monitoring plans, or the individual monitoring approaches utilized by the Central Valley Water Board if analyzed though UC or SWAMP. It is important to recognize that sampling frequency, total number of tests, and seasonality of monitoring did vary from Coalition to Coalition and from UC or SWAMP.

## INTERPRETATION OF THE DATA

The data was compared to water quality standards that are listed and/or described in each of the Basin Plans for the Central Valley, where possible. These Basin Plans are the Sacramento-San Joaquin Water Quality Control Plan and the Tulare Lake Basin Water Quality Control Plan. Because of their

geographic location, monitoring results from monitoring sites within the San Joaquin and Delta Coalition were also compared to water quality standards in the State Water Resources Bay-Delta Water Quality Control Plan. The application of standards and how they are compared to the monitoring results provided in this 2007 Review is dependent on the beneficial uses of the water body, as well as numeric and narrative objectives listed in the Basin Plans.

**Comparison To Standards.** Where applicable, this 2007 Review compares data to determine when numeric Basin Plan water quality objectives are exceeded. Where numeric objectives are not listed in the Basin Plan, or if they are not incorporated specifically by reference, as are the drinking water maximum contaminant levels (MCLs), an interpretation of narrative objectives was conducted. Both numeric objectives and limits selected through narrative interpretation are referred to as water quality "triggers" throughout this report. The interpretation of all objectives is contingent on the beneficial uses of the water body that is being monitored. Where specific beneficial use information for the monitored water bodies is not available, generalizations were presumed for the purpose of this Review. The reader is advised to consider this when independent conclusions are being drawn from this report.

The generalizations made in order to conduct this 2007 Review are as follows:

- Basin Plan water quality objectives are compared to the results. This includes numeric standards that are applied by reference in the Basin Plan, such as those listed in the California Drinking Water Maximum Contaminant Levels (MCLs);

- Most water bodies with monitoring sites are considered to include MUN (municipal water supply) as a beneficial use. The exceptions to this generalization occur only where Basin Plans specifically identify the beneficial uses of water bodies, and MUN is excluded. Examples of this exclusion are the waterbodies on the valley floor within Zone 4 (Tulare Lake Basin Plan, Table II-1);

- For the purpose of water quality assessment, it is assumed that all monitoring sites (with a few exceptions) are located on water bodies that are not constructed agricultural drains. Monitoring sites are generally assumed to have been located on waters of the State, including agricultural dominated water bodies. For monitoring sites on tributaries to water bodies with identified beneficial uses, the beneficial uses are established by the tributary rule.

- Attachment A to this 2007 Review provides the numeric values that were used to compare with the monitoring data for each Zone.

Due to these generalizations that are being made with respect to beneficial uses at each monitoring site, the objectives are referred to as water quality triggers

and are compared to numeric or narrative standards for the findings identified in this 2007 Review.

**Understanding Toxicity Results**. The correlation between toxicity measurements and receiving water impacts is well documented by the USEPA (USEPA Technical Support document For Water Quality-based Toxics Control, March 1991). Studies were conducted in order to identify relationships between test results for *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) to receiving water biological impact. The studies were able to show a strong correlation between the validity of toxicity tests as predictors of receiving water quality.

In addition to the water flea and fathead minnow tests, the Irrigated Lands Program monitoring utilizes one additional water column species, *Selenastrum capricornutum*, (algal species) and one sediment species (*Hyalella azteca*). Each of these species responds to different stressors in different ways, and in the absence of additional chemical data, or follow-up toxicity identification evaluations (TIE), toxicity test results can provide clues about the causes of water quality stressors.

When 100% mortality to the test species is observed in a field sample, the magnitude of toxicity can be quantified by diluting the sample with clean control water. The control water is shown to be non-toxic to the test species by exposing the organisms to the control water in a control sample. If 100% mortality is observed in a field sample, a series of dilutions of the field sample (using control water to dilute) are generally prepared and tested for toxicity to the test species. Toxic units are defined as dividing 100 by the percentage of the field sample portion in a dilution in which half of the test organisms survive. There are some references to dilution series and toxic units throughout this Review.

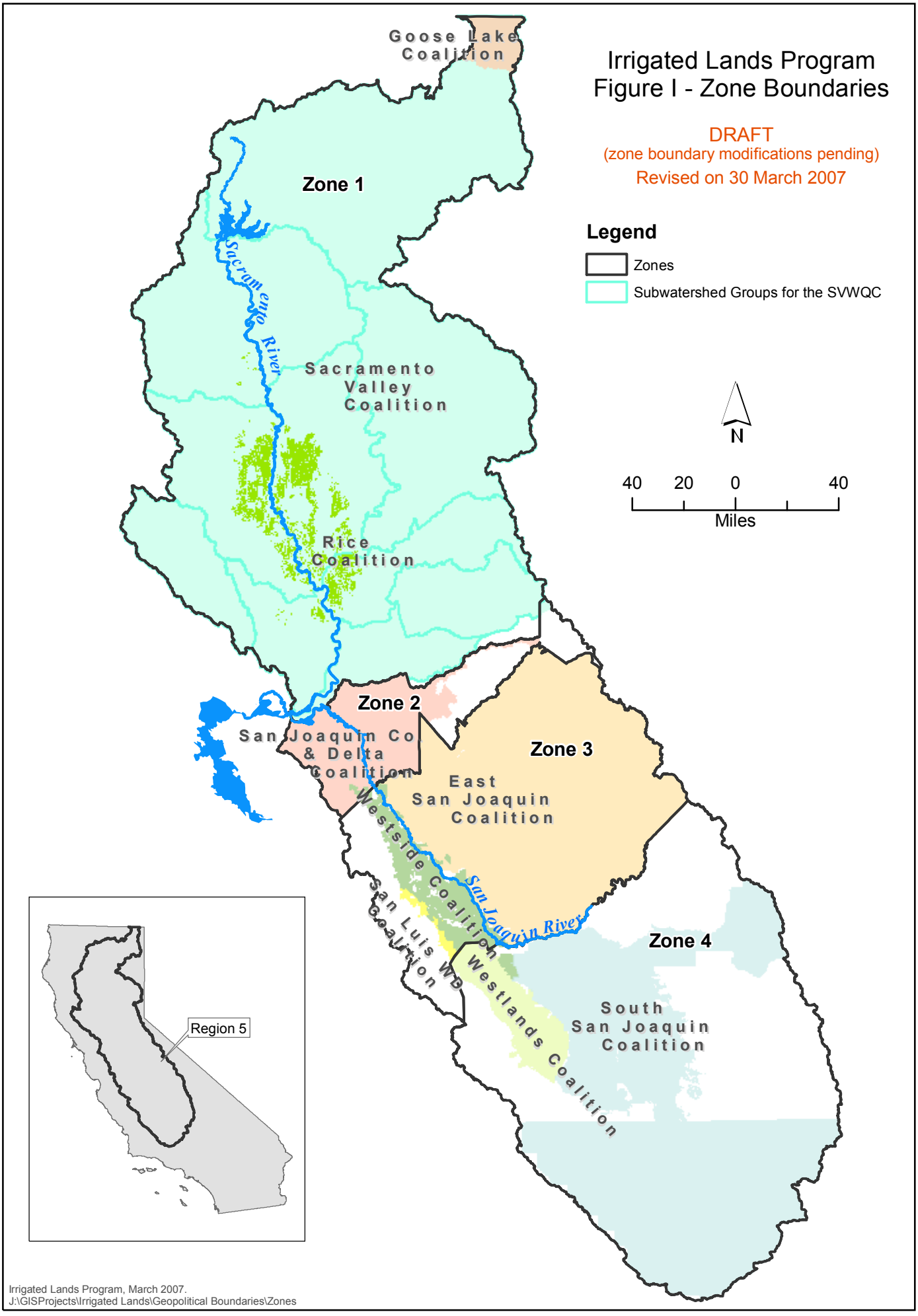
In general it can be said that the minnow is responsive to ammonia toxicity, and pesticides that are orders of magnitude levels higher than what might affect the water flea species. Mortality in the water flea is an indicator of insecticide toxicity, and if sufficient pesticide testing occurs at the same time as toxicity samples are collected, the cause of water flea toxicity can be compared to literature value LC50s for that species. Reduced growth to the *Selenastrum* is linked to metals including copper compounds and to herbicides such as diuron or simazine. Increased algal growth can also be caused by nutrients that are present in sample water, which may be a factor that complicates algae toxicity test results. However, these are only very general guidelines and it is critical to understand that all of the information collected at each monitoring site must be considered as a whole before conclusions are made.

Another value of the toxicity monitoring, is that it could provide critical information about the cumulative effect of multiple stressors, such as multiple pesticides or metals. Individually, each of these parameters may not be sufficiently high to result in an exceedance, but in combination they may well add to the toxicity and result in a detriment to water quality. Additionally, some chemical combinations

may result in a synergistic effect, which means that one or more chemical may physically react with another to create an increase in toxicity.

Toxicity monitoring of fathead minnow and water flea for the Irrigated Lands Program incorporates acute toxicity testing. Chronic and long-term effects, such as reproductive effects are not evaluated.

The following sections provide additional information about each zone, including crop production, pesticide use, monitoring locations and data summaries.


Irrigated Lands Program
Figure I - Zone Boundaries
DRAFT
(zone boundary modifications pending)
Revised on 30 March 2007
Legend
Zones
Subwatershed Groups for the SVWQC
N
40 20 0 40
Miles
Goose Lake Coalition
Zone 1
Sacramento River
Sacramento Valley Coalition
Rice Coalition
Zone 2
San Joaquin Co & Delta Coalition
Zone 3
East San Joaquin Coalition
Westside Coalition
San Luis WD Coalition
San Joaquin River
Zone 4
Westlands Coalition
South San Joaquin Coalition
Region 5
Irrigated Lands Program, March 2007.
J:\GISProjects\Irrigated Lands\Geopolitical Boundaries\Zones